Chemistry I: How to solve pH, pOH and related problems

Introduction:

1. pH and pOH are logarithmic functions. The logarithm is the mathematical operation that is the opposite of raising a number to a power. Logarithms were originally invented to make lengthy numerical operations easier to perform.

- The negative of the base-10 logarithm ($\log_{10}$) is used in Chemistry, where it expresses the concentration of hydronium ions. The concentration of hydronium ions in neutral water is 10^{-7}M at 25 °C, hence a pH of 7.

2. **You will need a calculator to do these calculations.**

3. The hydrogen ion concentration is in molar (M) concentration. This is shown to ways:
    1. $[H^+]$
    2. $[H_3O^+]$
4. Conversely the hydroxide concentration is also in molar concentration (M).

    this is shown only one way:
    1. $[OH^{-1}]$
5. The math formulas needed to do these problems looks like this:
    1. $\left[H^{+1}\right]\left[OH^{-1}\right]=\left[1\times10^{-14}\right]$
    2. $pH + pOH = 14$
    3. $pH = -\log_{10}\left[H^{+}\right]$
    4. $pOH = -\log_{10}[OH^{-1}]$
    5. $\left[OH^{-1}\right]=10^{-\mathrm{pOH}}$
    6. $\left[H^{+1}\right]=10^{-pH}$

Examples:

A. What is the pH of a solution that has a H^+ concentration of 0.000059 M ?

$$pH = -\log_{10}\left[0.000059\right] = 4.23$$ pH=4.23

B. What is the pOH of a solution that has a OH^{-1} concentration of 0.00039 M ?

$$pOH = -\log_{10}\left[0.00039\right] = 3.41$$ pOH=3.42

C. What is the pH of a solution that has a pOH of 8.79?

$$pH = 14.00 - 8.79 = 5.31$$ pH=5.31

D. What is the $[H^{+1}]$ of a solution that has a $[OH^{-1}]$ of 2.36 x 10^{-5} M?

$$[H^+][2.36\times10^{-5}] = [1\times10^{-14}]$$

$$[H^+] = \frac{\left[1\times10^{-14}\right]}{\left[2.36\times10^{-5}\right]} = 4.24\times10^{-10}$$ $[H^+]$= 4.24 x 10^{-10} M

E. What is the $[OH^{-1}]$ of a solution with the pH of 4.98?

$$pOH = 14.00 - 4.98 = 9.02$$

$$[OH^{-1}] = 10^{-9.02} = 9.55\times10^{-10}$$ $[OH^{-1}]$ = 9.55 x 10^{-10} M

F. What is the $[H^+]$ of a solution with a pH of 2.67?

$$\left[H^+\right] = 10^{-2.67} = 2.14\times10^{-3}$$ $[H^+]$ = 2.14 x 10^{-3} M